

4.3.1 Water-quality sample collection

Groundwater samples will be collected approximated 20 to 26 times per year, timing of which will be based on variation in the seasonal hydrologic cycle. Care will be used during purging and sampling to avoid undue turbulence in the water column and the development of large head-pressure differentials near the well screen area. The monitoring wells will be sampled using a low flow peristaltic pump (runs .1-30 ml/min) and a multi zone straddle packer that will isolate three 6-inch sample zones. (0-6, 12-18, 24-30) see figure 1 at back of report. The calculated volume of the open interval will be purged from the well and physical parameters of specific conductance, temperature and dissolved oxygen will be measured but may be constrained by the low volume being produced from each open interval. Utilizing a portable spectrophotometer field screening for NO₃, NH₃, and Fe²⁺ will be conducted after which samples will be collected for laboratory analyses of nutrient species and bacteria (colitert-18). Purge water generated during sample collection will be discharged at the down gradient edge of the sample plot.

4.4 Sample handling and documentation

The analytical method, reporting level, sampling containers, required volume, preservation, and sample hold times by analyte for water are presented in table 4. A field notes form is filled out each time a ground-water sample is collected (fig.2 at back of report). The form contains pertinent information on field personnel, sampling conditions, equipment used, instrument calibration, and filed measurements as well as well type and purging records. USGS sampling handling protocols including filtration, preservation, labeling, and shipping are described in USGS, 2006. The following are general descriptions of sample handling and custody protocols.

Commented [NU1]: Make sure that the samples collected for fecal coliform are collected aseptically and that the other testing mentioned as field screening is not done on just a portion of the pump sample. Preferably, the sample should be collected first for the coliform testing. Will they use an EPA certified lab for the testing? How will they clean or sanitize the sampling device between samples assuming they collect from more than one site during an event? Peristaltic pumps make it easy to just change out the entire tubing with new sterile tubing – hopefully that is their intent.

Table 1. Analytical methods, preservation, and analytical holding times for water samples.

[Cd; Cadmium; ICP-AES, Inductively Coupled Argon Plasma-Atomic Emission Spectrometry; IC, Ion-exchange chromatography; N, nitrogen; mg/L, milligrams per liter; ug/L, micrograms per liter; mL, milliliters]

Method number	Analytes	Instrument/ Method type	Reporting Level	Expected Range	volume	Preservation code ¹	Hold time (day)
Field measurements							
Hach 8171	Nitrate (NO ₃ +NO ₂)	Hach 2010 / Colorimetric Cd reduction	0.3 mg/L	<1-50.0 mg/L	25 mL	RU	Immediate
Hach 8146	Ferrous iron	Hach 2010 / Colorimetric 1,10 phenanthroline	.02 mg/L	3 - 3,000 ug/L	25 mL	RU	Immediate
Hach 8155	Ammonia	Hach 2010/ Colorimetric Salicylate	.01 mg/L	<1-50.0 mg/L	10 mL	RU	Immediate
Colilert-18	E. coli	MPN multiple well/ defined matrix	1 CFU/100 mL	1-2212	100	RUC	1
Laboratory analyses							
1-1472-87	Iron, total	ICP-AES	3.2 ug/L	3 - 3,000 ug/L	250 mL	FA	180
1-2545-90	Nitrate plus nitrite total as N	Colorimetric Cd reduction	.002 mg/L	<1-50.0 mg/L	125 mL	FCC	30
1-2525-89 1-2522-90	Ammonia as N	Colorimetric, DA	.010 mg/L	<1-50.0 mg/L	125 mL	FCC	30
1-2057-85	Chloride	IC	.06 mg/L		250 mL	FU	180
1-2650-03	Nitrogen, total	Alkaline persulfate digestion	.05 mg/L	<.05-50 mg/L	125 mL	FCC	30
1-1630-85	Potassium	ICP-AES	.022 mg/L	0.1 – 30 mg/L	250 mL	FA	180

Commented [NU2]: Need to be more specific – the hold time is actually 8 hours for anything that is not drinking water. However, if they wanted to use the 24 hour hold time, they should specify this rather than saying 1 day.

¹Preservation codes are described in table 4. When multiple analytes require the same preservation, the volume listed is the total volume required for the various analytes.

Table 1. Description of preservation codes.

[mL, millitlier; µm, micrometer]

Code	Description
RU	Raw (unfiltered) untreated water sample. Sample is placed in a 250-mL polyethylene bottle without treatment or preservation. Bottle is field rinsed with unfiltered sample.
FA	Field filtered water sample. Sample is filtered using a 0.45 µm disposable capsule filter. Filtrate is placed into a 250 -mL polyethylene bottle and acidified to pH less than 2 using 2 mL of trace-metal grade nitric acid. The preservative is supplied in individual 2-mL ampules. Bottles are rinsed with 10% nitric acid at the laboratory.

Commented [NU3]: Doesn't work for microbiology. They should not field rinse the bottle and the bottle should be sterile – hence no field rinsing. PE is usually sterilized using irradiation or gas as it doesn't tolerate the pressure/heat associated with autoclaves. They don't identify the "C" in RUC in this table.. does that mean chilled?

FU	Field filtered water sample. Sample is filtered using a 0.45 µm disposable capsule filter. Filtrate is placed into a 250 -mL polyethylene bottle and shipped to the laboratory without additional treatment. Bottle is field rinsed with filtered sample.
FCC	Field filtered water sample. Sample is filtered using a 0.45 µm disposable capsule filter. Filtrate is placed into a 125 -mL brown polyethylene bottle and chilled to 4 °C for shipment to the laboratory. Bottle is field rinsed with filtered sample.

4.5.2 Equipment decontamination

All water-quality and support equipment (such as peristaltic pump hose, pump tubing, packer, steel or electric tapes) will be decontaminated thoroughly prior to and between each use according to USGS protocols described in (Wilde, F.D 2004 and Myers et al 2007). The general decontamination protocol to be followed for sampling equipment is a 0.1 percent Liquinox-tap water wash and scrub followed by successive rinses in tap water and DI. In instances where bacteria samples will be collected an additional step of sterilizing equipment with a .005 percent sodium hypochlorite solution will be conducted. Dedicated sampling tubing will be used for each open interval for each well (4 sample tubing per well). This tubing will be cleaned and sterilized prior to sampling at the WaWSC.

Commented [NU4]: This could be a big problem unless they ensure that all the chlorine residual is removed from the tubing prior to sample collection. They could neutralize the chlorine by flushing the line with sodium thiosulfate... or just water and then testing the water for chlorine prior to sample collection for bacteria.

4.7 Microbial sampling and analysis

It is anticipated that more field data on concentration of total coliforms and E. coli can be generated by using enzyme-based methodologies than more traditional membrane filtration or multiple tube fermentation method. This methodology has been used in rural surface water studies (Kloot and others 2006) many studies of coastal water and sediments of California (Rosenfeld and other 2006).

Colilert-18 and Enterolert enumeration methods are based on defined substrate technology and these methods have been used extensively to analyze water and soil/sediment samples for E. coli and enterococci (Muruleedhara and others 2006.)

Aseptic field techniques will be used during the collection of groundwater samples for analysis of bacterial constituents. Bacterial enumeration of water samples may require serial dilution. An autoclave will be used for sterilization of sampling equipment in the laboratory. If field sterilization is necessary a 0.5 % bath of bleach solution will be followed by DI rinse and confirmation testing by collection of field blank samples. Rinse blanks of sampling equipment and positive control samples will be included in all batches of bacterial samples.

Commented [NU5]: All good stuff. Especially if they make sure that the tubing used for collection is free of chlorine prior to sample collection.

Commented [NU6]: There will be a difference in results between USGS (E. coli) and Whatcom's fecal coliform testing. Usually (but not always) fecal coliform counts will be higher.....